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<i>Ehud Heyman Elene E. Tsedilina</i>		
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<p>ABSTRACT</p> <p>The differences in critical frequencies of the ionosphere between measured values of the European continent and the model parameters of "International Reference Ionosphere of 1990" were considered. In general, absolute relative differences of foF2 are of the order of 10 percent. They increase for twilight and night periods up to 20 or 30 percent. Relative difference for foE are less than 5 percent for day-time periods and usually are larger for twilight periods.</p>		
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ABSTRACT

The method of the analysis of vertical sounding ionograms, written in ARTIST codes, for the study of the spread of the reflection echoes in the upper ionosphere or the sporadic F layer is evaluated. The processing and the analysis of the computer ionograms for the station Roquetes, Spain was made from December to May of 1991 (approximately 4300 ionograms) according to this method. The examples of the ionograms with strong spread of signals and first results of their analysis are given.

KAY WORDS

Ionosphere, F layer, analysis, computer vertical ionograms, spread of the echo, indexes, processing, probability, number of cases, sporadic layer F_S , program for imprint and view of ionograms

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CORRELATION AND GRADIENT CHARACTERISTICS OF IONOSPHERIC PARAMETERS IN EUROPE

by

**E. Heyman
E. E. Tsedilina
O. V. Weitsman**

**RAMOT BY TEL AVIV UNIVERSITY
DEPARTMENT OF PHYSICAL ELECTRONICS,
FACULTY OF ENGINEERING**

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2nd Interim Report

December 1994 - February 1994

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1. STATEMENT OF WORK

1.1. For the reason of the evaluation of the scattering conditions in the upper ionosphere (F1, F2 layers) and irregularities we performed the computer processing of the ionograms from the station Roquetes, Spain, 1991. These ionograms were written on diskettes in special codes conforming to the program ARTIST (B.W. Reinish, New techniques in ground-based ionospheric sounding and studies, Radio Science, 21,331-341, 1986). These codes and the format used in these ionograms did not allow us to view them in usual form on one computer screen. That why for processing and printing the ionograms we used the computer program TURBO-PASKAL that was published in the Report "Analysis of ionospheric parameters in Europe and creation of the prediction algorithm", 1993, Contract DAJA45-92-C0006. This program was updated in some ways. For instance, the general parameters of the ionosphere layers such as f_0F2 , f_0F1 , f_0E , f_0E_S , MUF, M300, $h'F$, $h'F2$, $h'E$, $h'E_S$, f_{min} , f_XF , ff , FE , that are determined by the ARTIST program, are given and can be printed now together with ionogram. The TURBO-PASKAL program is made now in more convenient form for the user. It treats now ionograms in archives codes written on the diskettes which amount is ten times less than the amount of previous diskettes with usual codes. This fact makes much easier the ionogram processing.

1.2. To reveal the scattered conditions of the signals on the ionograms or the spread of the F echoes we evaluated special indexes with points and letters. They describe the type of echo signal on the ionogram and the whole picture. Strong disturbed traces in F region with frequency spread are determined by the letters f, ff, fff (accordingly with points 4, 5, 6) that describe strong, very strong and very, very strong disturbed traces with frequency spread of signals. Corresponding range spread of echo was determined by the letter r, and mixed type of spread - by both letters rf. The letters c, cc, ccc with points 1, 2, 3 are used for determining the traces with very small, small and close to strong types of spread. We use also evaluative letters such as B - for absorption, S - for noises, w - for week signal, A - for breaks in traces, E - for covering F-traces by repeating reflections from E region (from E, E_S layers), T - for technical reasons of violations.

Examples of ionograms with different indexes for F echoes and evaluating operative table for May 1991 are shown in Appendix. All ionograms with

indexes f , ff , fff , r , rf , rff , obtained after their visual viewing, are printed. Their amount for one month varies from 10-15 ionograms to 60-80. The indication of the F-traces for every hour is entered in the special note-book with some notices about the state of ionograms and F-traces. There are noted the approximate values of mistakes in f_0F2 that was made by the ARTIST program (20 %- 25% from the whole number of ionograms with errors in Δf_0F2 of the order from 0,3 to 4 MHz), their type and value, and also the appearance of sporadic layer E_S .

1.3 The first results of processing approximately 4300 ionograms for 6 months of 1991 from December to May, and their analysis are given in Tables 1-4 and Figures 1-3. One can see from these data season and terminator effects in the appearance of strong F spread echoes and scattered F traces.

2. RESEARCH PROGRAMS

Next we are going to consider and perform the work:

1. To continue the computer processing, indication and analysis of the ionograms from the station Roquetes, Spain, 1990. This work will be done according to upper described scheme for the last half of the year (six months from June to November) for the evaluation of the spread of the F-echo and the scattering conditions in the upper ionosphere.
2. Preparation of the results of the ionogram analysis for reports and publication.

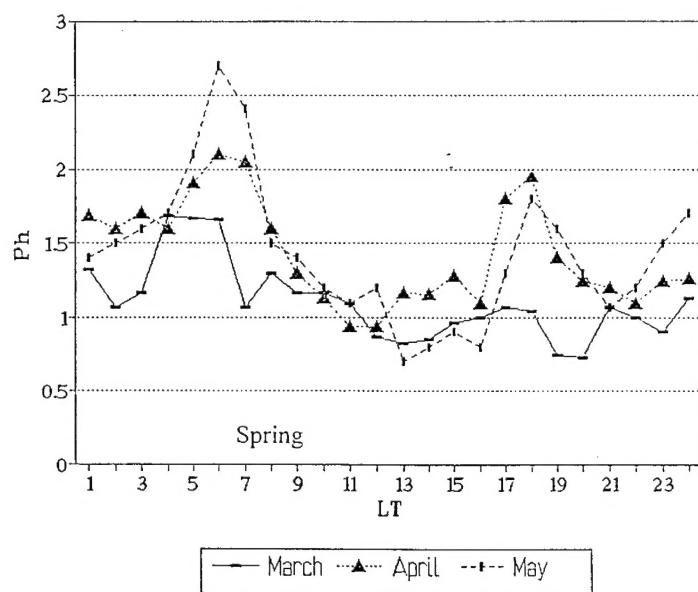
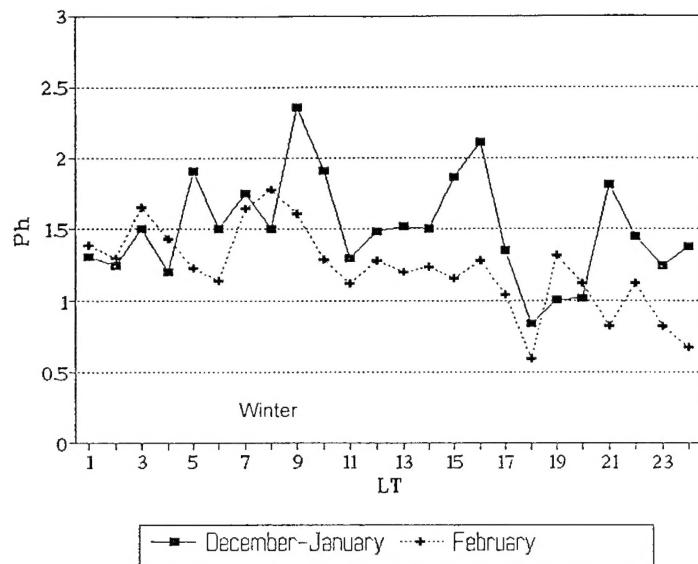


Fig. 1. Variations of hour probability P_h , station Roquetes, December-May, 1991.

Table 1. Hour probability P_h of F -traces with scattered signals.

Hour\Month	Dec-Jan	February	March	April	May
01	1.31	1.39	1.33	1.68	1.40
02	1.25	1.30	1.07	1.60	1.50
03	1.50	1.65	1.17	1.70	1.60
04	1.20	1.43	1.68	1.60	1.70
05	1.90	1.23	1.67	1.90	2.10
06	1.50	1.14	1.66	2.10	2.70
07	1.75	1.64	1.07	2.05	2.40
08	1.50	1.77	1.30	1.60	1.50
09	2.35	1.61	1.17	1.30	1.40
10	1.90	1.29	1.17	1.13	1.20
11	1.30	1.12	1.10	0.94	1.10
12	1.48	1.28	0.87	0.94	1.20
13	1.52	1.20	0.83	1.17	0.70
14	1.50	1.24	0.85	1.16	0.80
15	1.86	1.16	0.97	1.28	0.90
16	2.11	1.28	1.00	1.10	0.80
17	1.35	1.04	1.07	1.80	1.30
18	0.84	0.60	1.04	1.95	1.80
19	1.01	1.32	0.75	1.40	1.60
20	1.02	1.12	0.73	1.25	1.30
21	1.81	0.83	1.07	1.20	1.07
22	1.45	1.12	1.00	1.10	1.20
23	1.25	0.83	0.90	1.25	1.50
24	1.38	0.67	1.13	1.26	1.70

Table 2. Number N_s of F -traces with strong spread : f,ff,fff,fr,r ;
December - May 1991.

Hour \Month	Dec-Jan	February	March	April	May
01		1		1	
02				1	1
03			1	2	3
04	1	2	2	2	4
05	2	1	2		4
06	3	1	3	3	5
07	2			3	6
08	2				2
09	3				
10	1				
11					
12					
13					
14				1	
15				1	
16					
17					1
18				1	2
19					1
20	1				
21	3				
22	2				
23	2				
24	1				

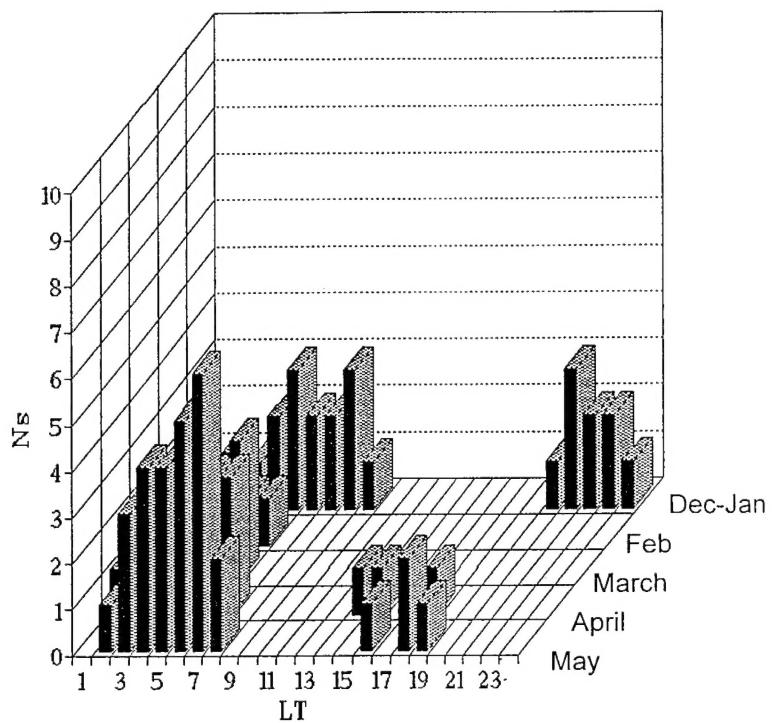


Fig. 2. Number of strong spread F echo, station Roquetes, December-May 1991.

Table 3. Mean month probability P_m of F -traces with spread signals and full number N_d of strong spread echo (f, ff, fff, fr, r) for December-May 1991; R - mean sunspot number

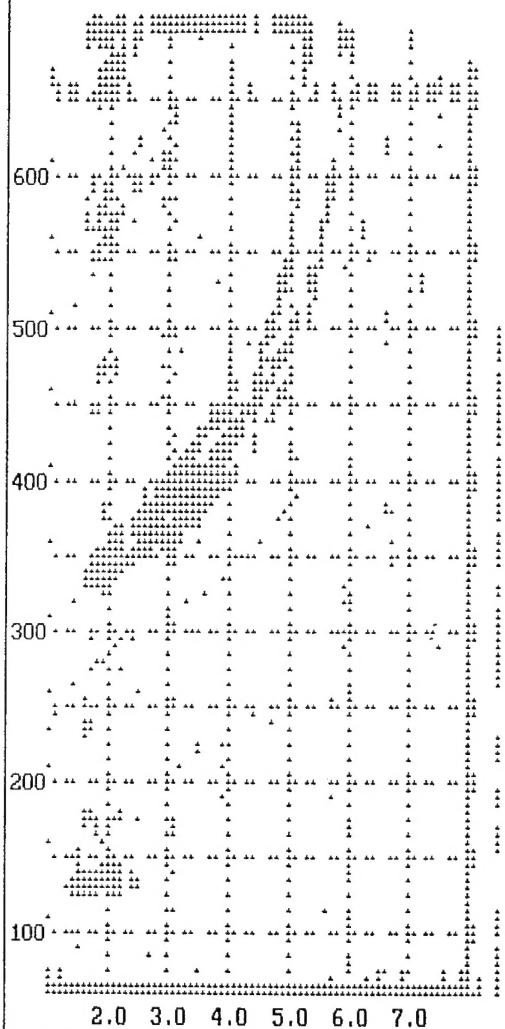
Month	Dec-Jan	February	March	April	May
P_m	1.50	1.21	1.08	1.44	1.40
N_s	23	5	8	15	29
R	140.6	167.9	141.9	140.0	121.3

APPENDIX

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May 1991

foF2	foF1	foE	foEs	MUF	M3000	h'F	h'F2	h'E	h'ES	fmin	fxI	ff	fE
5.20	****/***P	****/	.9P	****	12.6	2.42	327	***	90	***	1.70	5.9	***

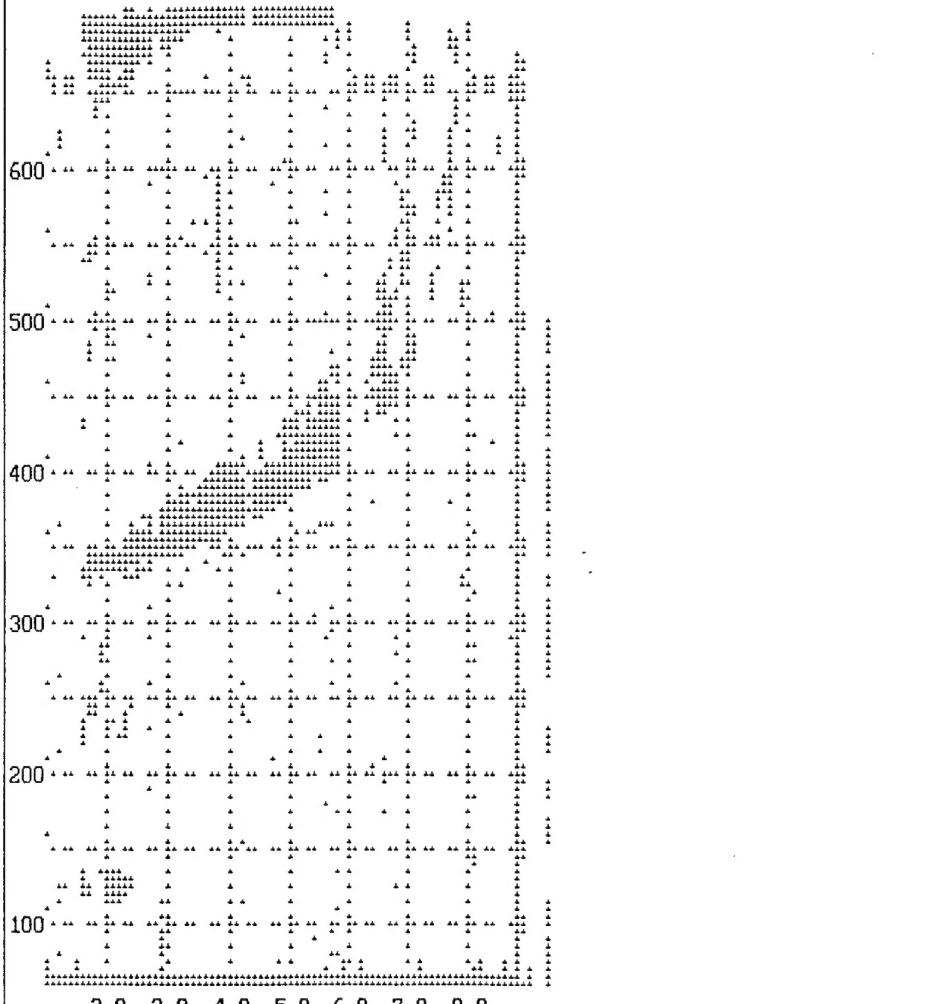


1991 DAY 152 02:59 UT	FOF2= 5.2 MHz
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Press < N > or < Enter > next, < B > step back, < P > print, < Esc > exit

1 June 1991, index fw

foF2	foF1	foE	foEs	MUF	M3000	h'F	h'F2	h'E	h'Es	fmin	fxI	fF	fE
5.70	****/****P	****/	.6P	****	16.8	2.95	337	***	90	***	2.30	6.7	,3 ***

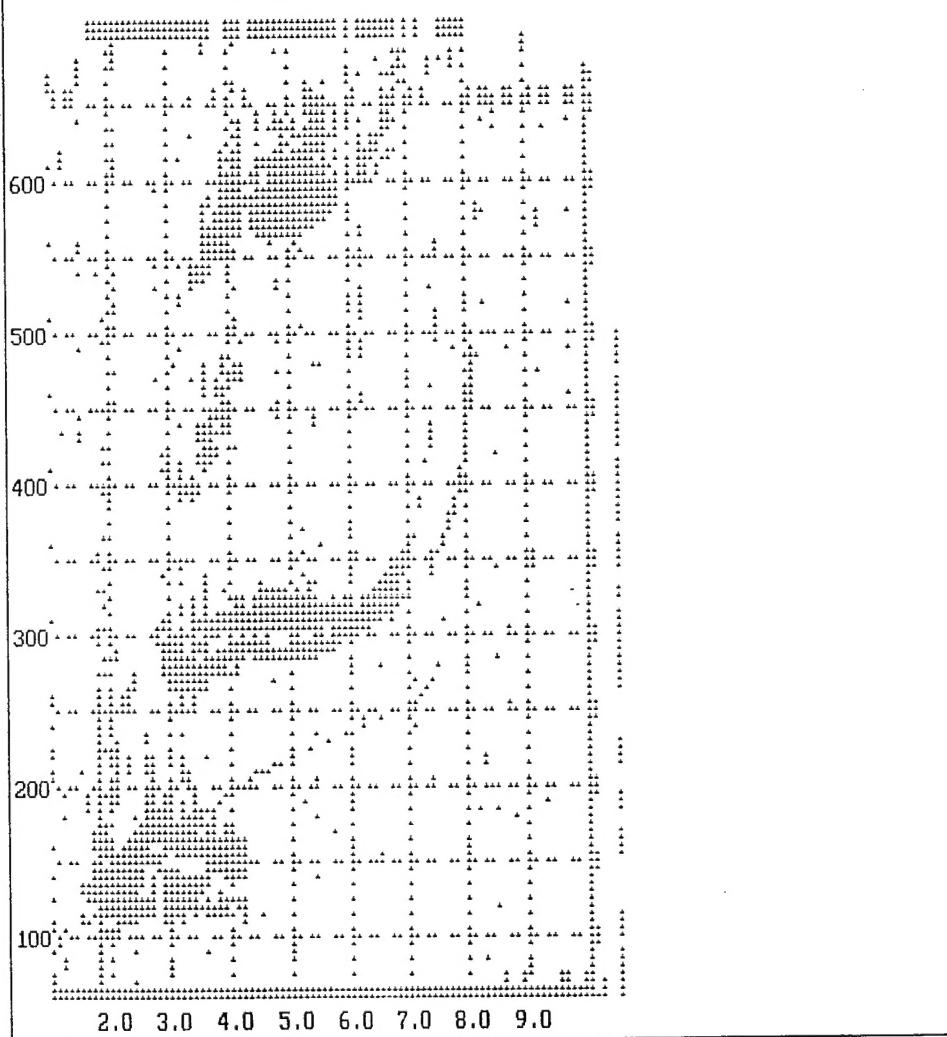


1991 DAY 159 01:59 UT	FOF2= 5.7 MHz
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8 June 1991, index ff

foF2	foF1	foE	foEs	MUF	M3000	h'F	h'F2	h'E	h'ES	fmin	fxI	fF	fE
7.50	4.20/4.9P	2.70/2.6P	3.60	23.1	3.08	260	287	125	135	1.60	8.3	***	.4



1991 DAY 148 05:59 UT	foF2= 7.5 MHz
Press < N > or < Enter > next, < B > step back, < P > print, < Esc > exit	

28 May 1991, index frE